Sensing Devices

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Current of Electricity
Sub Topic	Sensing Devices
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** p.d. = work done / energy transformed (from electrical to other forms)
charge B1 [1]

(b) (i) maximum 20 V A1 [1]

(ii) minimum = (600 / 1000) × 20 C1
= 12 V A [2]

(c) (i) use of 1.2 kΩ M1
1/1200 + 1/600 = 1/*R*, *R* = 400 Ω A1 [2]

(ii) total parallel resistance (R_2 + LDR) is less than R_2 M1
(minimum) p.d. is reduced A1 [2]

2 **(a** total resistance = 20 (kΩ) C1
current = 12 / 20 (mA) or potential divider formula C1
p.d. = [12 / 20] × 12 = 7.2 V A1 [3]

(b) parallel resistance = 3 (kΩ) C1
total resistance 8 + 3 = 11 (kΩ) C1
current = 12 / 11 × 10^3 = 1.09 × 10^{-3} or 1.1 × 10^{-3} A A1 [3]

(c) (i) LDR resistance decreases M1
total resistance (of circuit) is less hence current increases A1 [2]

(ii) resistance across XY is less M1
less proportion of 12 V across XY hence p.d. is less A1 [2]

3 **(a)** *either* $V = E\,R_1 / (R_1 + R_2)$ *or* $I = E / (R_1 + R_2)$ C1

$= \frac{1800}{3000} \times 4.50$ $V = \frac{1800}{3000} \times 4.50$ M1

$= 2.70$ V $= 2.70$ V A0 **[2]**

(b) **(i)** for a wire, $V = I \times (\rho L/A)$ M1

I, ρ *and* A are constant A1

so $V \propto L$ A0 **[2]**

(ii) **1** 2.70 V A1 **[1]**

2 $\frac{L}{100} = \frac{2.70}{4.50}$ C1

$L = 60.0$ cm A1 **[2]**

(iii) thermistor resistance decreases as temperature rises M1

so QM is shorter A1 **[2]**

4 **(a)** **(i)** non-inverting (amplifier) B1 [1]

(ii) $(G =)\ 1 + R_2 / R_1$ B1 [1]

(b) **(i)** gain = 1 + 100 / 820 C1

output = 17 mV A1 [2]

(ii) 9 V A1 [

(R_2 / R_1 scores 0 in **(a)(ii)** but possible 1 mark in each of **(b)(i)** and **(b)(ii)**
($1 + R_1 / R_2$) scores 0 in **(a)(ii)**, no mark in **(b)(i)**, possible 1 mark in **(b)(ii)**
($1 - R_2 / R_1$) or R_1 / R_2 scores 0 in **(a)(ii), (b)(i)** and **(b)(ii)**)

5 **(a) (i)** point X shown correctly B1 [1]

(ii) op-amp has very large / infinite gain M1
non-inverting input is at earth (potential) / earthed / at 0 V M1
if amplifier is not to saturate, inverting input must be (almost)
at earth potential / 0 (V) same potential as inverting input A1 [3]

(b) (i) total input resistance = 1.2 kΩ C1
(amplifier) gain (= –4.2 / 1.2) = –3.5 C1
(voltmeter) reading = -3.5×-1.5
= 5.25 V A1 [3]
(total disregard of signs or incorrect sign in answer, max 2 marks)

(ii) (less bright so) resistance of LDR increases M1
(amplifier) gain decreases M1
(voltmeter) reading decreases A1 [3]

6 **(a) (i) 1.** inverting (amplifier) B1 [1]

2. gain of op-amp is very large / infinite B1
non-inverting input is at earth / 0 V B1
for amplifier not to saturate, P must be at about earth / 0 V B1 [3]

(ii) input resistance is very large B1
(so) current in R_1 = current in R_2 B1
$I = V_{IN} / R_1$ B1
$I = -V_{OUT} / R_2$ (*minus sign can be in either of the equations*) B1
hence *gain* = $V_{OUT} / V_{IN} = -R_2 / R_1$ A0 [4]

(b) (i) 1. feedback resistance = 33.3 kΩ C1
gain (= 33.3 / 5) = 6.66 C1
V_{OUT} (= 6.66×1.2) = 8.0 V (+ *or* – *acceptable, allow 1 s.f.*) A1 [3]

2. feedback resistance = 8.33 kΩ C1
V_{OUT} (= {6.66×1.2} / 5) = 2.0 V (+ *or* – *acceptable, allow 1 s.f.*) A1 [2]

(ii) (Increase in lamp-LDR distance gives) decrease in intensity M1
Feedback / LDR resistance increases M1
voltmeter reading increases / becomes more negative A1 [3]